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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
09/926,188	09/20/2001	Toshihiro Ando	011147	4371

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EXAMINER

SONG, MATTHEW J

ART UNIT	PAPER NUMBER
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1765

DATE MAILED: 09/15/2003

CS

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary

Application No.

09/926,188

Applicant(s)

ANDO ET AL.

Examiner

Matthew J Song

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-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☒ Responsive to communication(s) filed on 14 July 2003.
- 2a) ☐ This action is FINAL. 2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 1-4, 6, 7 and 20 is/are pending in the application.
- 4a) Of the above claim(s) _____ is/are withdrawn from consideration.
- 5) ☐ Claim(s) _____ is/are allowed.
- 6) ☒ Claim(s) 1-4, 6, 7 and 20 is/are rejected.
- 7) ☐ Claim(s) _____ is/are objected to.
- 8) ☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☐ The drawing(s) filed on _____ is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.
- Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
- 11) ☐ The proposed drawing correction filed on _____ is: a) ☐ approved b) ☐ disapproved by the Examiner.
- If approved, corrected drawings are required in reply to this Office action.
- 12) ☐ The oath or declaration is objected to by the Examiner.

Priority under 35 U.S.C. §§ 119 and 120

- 13) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☐ All b) ☐ Some * c) ☐ None of:
1. ☐ Certified copies of the priority documents have been received.
2. ☐ Certified copies of the priority documents have been received in Application No. _____.
3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).
- * See the attached detailed Office action for a list of the certified copies not received.
- 14) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application).
- a) ☐ The translation of the foreign language provisional application has been received.
- 15) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121.

Attachment(s)

- 1) ☒ Notice of References Cited (PTO-892)
- 2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
- 3) ☐ Information Disclosure Statement(s) (PTO-1449) Paper No(s) _____
- 4) ☐ Interview Summary (PTO-413) Paper No(s). _____
- 5) ☐ Notice of Informal Patent Application (PTO-152)
- 6) ☐ Other:

DETAILED ACTION

Continued Examination Under 37 CFR 1.114

1. A request for continued examination under 37 CFR 1.114, including the fee set forth in 37 CFR 1.17(e), was filed in this application after final rejection. Since this application is eligible for continued examination under 37 CFR 1.114, and the fee set forth in 37 CFR 1.17(e) has been timely paid, the finality of the previous Office action has been withdrawn pursuant to 37 CFR 1.114. Applicant's submission filed on 6/11/2003 has been entered.

Claim Rejections - 35 USC § 112

2. The following is a quotation of the first paragraph of 35 U.S.C. 112:

The specification shall contain a written description of the invention, and of the manner and process of making and using it, in such full, clear, concise, and exact terms as to enable any person skilled in the art to which it pertains, or with which it is most nearly connected, to make and use the same and shall set forth the best mode contemplated by the inventor of carrying out his invention.

3. Claims 1-4, 6-7 and 20 are rejected under 35 U.S.C. 112, first paragraph, as failing to comply with the written description requirement. The claim(s) contains subject matter, which was not described in the specification in such a way as to reasonably convey to one skilled in the relevant art that the inventor(s), at the time the application was filed, had possession of the claimed invention. Claim 1 recites, "wherein said n-type semiconductor diamond exhibits crystal completeness sufficient to allow operation of said n-type semiconductor diamond as p-n junction device" in lines 11-12, likewise for claim 3. The instant specification merely discloses the n-type semiconductor diamond has a high crystal perfectness, which can be used to form a pn junction (pg 4, ln 31 to pg 5, ln 5). The instant specification does not provide support a crystal

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completeness sufficient to allow operation of said n-type semiconductor diamond as a p-n junction device.

4. The following is a quotation of the second paragraph of 35 U.S.C. 112:

The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.

5. Claims 1-4, 6-7 and 20 are rejected under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention. Claim 1 recites "wherein said n-type semiconductor diamond exhibits crystal completeness sufficient to allow operation of said n-type semiconductor diamond as p-n junction device" in lines 11-12, likewise for claim 3. It is unclear what is "crystal completeness". The instant specification does not define what the parameters are for a crystal to have a "completeness" sufficient to allow operation of a n-type semiconductor as a pn junction.

Claim Rejections - 35 USC § 103

6. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

This application currently names joint inventors. In considering patentability of the claims under 35 U.S.C. 103(a), the examiner presumes that the subject matter of the various claims was commonly owned at the time any inventions covered therein were made absent any evidence to the contrary. Applicant is advised of the obligation under 37 CFR 1.56 to point out

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the inventor and invention dates of each claim that was not commonly owned at the time a later invention was made in order for the examiner to consider the applicability of 35 U.S.C. 103(c) and potential 35 U.S.C. 102(e), (f) or (g) prior art under 35 U.S.C. 103(a).

7. Claims 1-4, 6-7 and 20 are rejected under 35 U.S.C. 103(a) as being unpatentable over Imai et al (US 5,001,452) in view of Imai et al (JP 01-103994), an English Abstract and an English Translation have been provided, along with Jin et al (US 5,977,697).

Imai et al ('452) discloses a method of forming a n-type diamond semiconductor (col 1-8) using a reaction gas composed of CH_4 , H_2S and H_2 to form S-doped diamond films on the (100) face of a single crystal diamond substrate by microwave plasma assisted CVD process (Example 1) with a electron mobility of $590 \text{ cm}^2/\text{V}\cdot\text{s}$ (Table 1).

Imai et al ('452) does not disclose mechanically polishing a diamond substrate to make it an inclined diamond substrate.

In a method of growing a diamond single crystal free from defects and having a smooth surface by specifying the orientation of the growth face of the substrate, Imai et al (JP '994) teaches a diamond single crystal layer is grown on a diamond single crystal substrate in a vapor phase, where a polished face having less than a 8° angle to the face orientation of (111) or (100) face is used as the growth face of the substrate and by this method a diamond single crystal layer having satisfactory crystallinity and a flat surface can easily be produced (Abstract).

It would have been obvious to a person of ordinary skill in the art at the time of the invention to modify Imai et al ('452) with Imai et al (JP '994) to grow of crystal of diamond free of defects and having a smooth surface.

The combination of Imai et al ('452) and Imai et al (JP '994) does not disclose subjecting a surface of the inclined diamond substrate to a smoothening treatment making it even.

In a method of forming diamond emitters, note entire reference, Jin et al teaches a diamond thin film is loaded into a microwave plasma chamber for surface treatment, this reads on applicant's smoothening treatment, where the plasma was pure hydrogen and the plasma chamber was operated at a microwave power of 1 kW (1000 W) and a total pressure of 20 Torr, a substrate temperature of 700°C and plasma exposure for 60 minutes. Jin et al also teaches after the treatment process the sample was subjected to a diamond overcoat process in the plasma chamber using methane gas at a substrate temperature of 700°C (col 9, ln 45-67). Jin et al also teaches the hydrogen plasma cleans the diamond surface by removing carbonaceous and oxygen or nitrogen related contaminants and also introduces hydrogen-terminated diamond surface and the plasma also removed any graphite or amorphous carbon phases present on the surface and along the grain boundaries (col 5, ln 15-67).

It would have been obvious to a person of ordinary skill in the art at the time of the invention to modify the combination of Imai et al ('571) and Imai et al (JP '994) with Jin et al to clean the surface and remove amorphous phases, thereby improving crystallinity.

Referring to claim 1-2, the combination of Imai et al ('571), Imai et al (JP '994) and Jin et al teaches a similar method of making a n-type semiconductor diamond as applicant. the combination of Imai et al ('571), Imai et al (JP '994) and Jin et al is silent to the crystalline perfectness, the Raman peak, a Kikuchi pattern, carrier concentration and carrier mobility of the n-type diamond and the n-type semiconductor diamond exhibits crystal completeness sufficient to allow operation of said n-type semiconductor diamond as a pn junction device. It is inherent to

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the n-type diamond taught by the combination of Imai et al ('571), Imai et al (JP '994) and Jin et al to have same because the combination of Imai et al ('571), Imai et al (JP '994) and Jin et al teaches a similar method of forming a n-type diamond as applicant.

Referring to claim 3, the combination of Imai et al ('571), Imai et al (JP '994) and Jin et al teaches a polished inclined diamond substrate with an angle of less than 8° and smoothening the substrate prior to deposition of a n-type diamond by microwave plasma.

Referring to claim 4, the combination of Imai et al ('571), Imai et al (JP '994) and Jin et al teaches a (100) orientated substrate.

Referring to claim 6, the combination of Imai et al ('571), Imai et al (JP '994) and Jin et al teaches a pressure of 20 Torr, a microwave output of 1000 W, a temperature of 700°C for a period of 1 hour.

Referring to claim 7, the combination of Imai et al ('571), Imai et al (JP '994) and Jin et al teaches a temperature of 700°C.

Referring to claim 20, the combination of Imai et al ('571), Imai et al (JP '994) and Jin et al teaches a temperature of 700°C. Temperature is well known in the art to be a result effective variable, note Tsuno et al (US 5,474,021) below. It would have been obvious to a person of ordinary skill in the art at the time of the invention to modify the combination of Imai et al ('571), Imai et al (JP '994) and Jin et al by optimizing the temperature by conducting routine experimentation of a result effective variable (MPEP 2144.05).

Response to Arguments

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8. Applicant's arguments filed 7/14/2003 have been fully considered but they are not persuasive.

Applicant's argument that the combination of Imai et al ('452), Imai et al ('994) and Jin et al does not teach the limitation of a n-type semiconductor exhibits crystal completeness sufficient to allow operation of said n-type semiconductor diamond as a pn junction device is noted but is not found persuasive. The examiner has admitted the combination of Imai et al ('452), Imai et al ('994) and Jin et al does not explicitly teach this limitation. However, the limitation is held to be inherent to the invention taught by the combination of Imai et al ('452), Imai et al ('994) and Jin et al because the combination of Imai et al ('452), Imai et al ('994) and Jin et al teach a similar method, as applicant, for forming an n-type diamond.

In response to applicant's argument that the references fail to show certain features of applicant's invention, it is noted that the features upon which applicant relies (i.e., interstitial impurities, dislocation, vacancy or lattice distortion (pg 4)) are not recited in the rejected claim(s). Although the claims are interpreted in light of the specification, limitations from the specification are not read into the claims. See *In re Van Geuns*, 988 F.2d 1181, 26 USPQ2d 1057 (Fed. Cir. 1993).

In response to applicant's argument that S or Se **might** cause a Frenkel defect rather than substitution in regular carbon lattice sites and this **may** also serve to create donor levels (pg 6) has been considered but has not been found persuasive. Applicant's arguments are based on possible scenarios, which **may** or may not occur. There is no evidence provided, which shows the Imai et al ('452) reference would not be able applicable to a p-n junction device. Furthermore, the combination of Imai et al ('571), Imai et al (JP '994) and Jin et al teach a

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similar method of forming a n-type semiconductor, as applicant, therefore a n-type of similar properties will inherently be formed, absent evidence to the contrary.

In response to applicant's arguments against the references individually, one cannot show nonobviousness by attacking references individually where the rejections are based on combinations of references. See *In re Keller*, 642 F.2d 413, 208 USPQ 871 (CCPA 1981); *In re Merck & Co.*, 800 F.2d 1091, 231 USPQ 375 (Fed. Cir. 1986). Applicant alleges that the diamond taught by Imai '452 would not operation as a pn junction device because of the leak current at the pn junction based on lattice defects. The rejection is based on the entire method of forming a n-type diamond as claimed is taught by the combination of Imai et al ('452), Imai et al ('994) and Jin et al. Imai '994 teach a method of polishing a substrate to have an incline to manufacture a diamond having satisfactory crystallinity (Abstract) and Jin et al teaches smoothening a substrate to remove amorphous phases (col 5, ln 15-67), which would improve crystallinity. Furthermore, applicant admits it is merely **difficult** for the n-type diamond to operate as a pn junction device (pg 6), there is no suggestion that the diamond taught by Imai '452 would not be capable of forming a pn junction device.

Conclusion

4. The prior art made of record and not relied upon is considered pertinent to applicant's disclosure.

Tsuno et al (US 5,474,021) teaches the temperature and growth plane of a substrate are result effective variable for the growth of diamond single crystal by microwave plasma CVD (Example 1).

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9. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Matthew J Song whose telephone number is 703-305-4953. The examiner can normally be reached on M-F 9:00-5:00.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Nadine Norton can be reached on 703-305-2667. The fax phone number for the organization where this application or proceeding is assigned is (703) 872-9306.

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the receptionist whose telephone number is 703-308-0661.

Matthew J Song
Examiner
Art Unit 1765

MJS

NADINE G. NORTON
PRIMARY EXAMINER

